FRAGMENT PERFORMANCE OF CURRENT AND NEW BALLISTIC MATERIALS

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BALLISTIC TERMINOLOGY

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- **AREAL DENSITY**
  - WEIGHT PER UNIT AREA
- **BULLETS**
  - HAND-GUN BULLETS
  - RIFLE BULLETS
  - ARMOR PIERCING BULLETS
- **FRAGMENTS**
  - FSP & RCC
- **TEST SPECIFICATIONS**
  - MILITARY (PRODUCT & PERFORMANCE SPECIFICATION)
- **BALLISTIC LIMITS**
  - V50 & V0

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BALLISTIC FIBERS

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- **REINFORCING FIBERS**
  - **HMPE (SPECTRA® Fibers)**
  - **ARAMID FIBERS**

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FIBER PROPERTIES

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PROPERTY	SPECTRA® Fiber	ARAMID Fiber*
TENACITY (g/d)	30-35	22-26
MODULUS (g/d)	1400-2000	488-976
ELONGATION (%)	2.7-3.5	2.8-3.6
DENSITY (g/cc)	0.97	1.44

*** Published Values. Test methods differ and can affect results.**

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BALLISTIC MATERIALS

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- **HONEYWELL'S PATENTED SHIELD TECHNOLOGY**
  - UNIDIRECTIONAL CROSSPLIED MATERIALS
    - ***SPECTRA*® FIBER BASED "SHIELDS"**
    - **ARAMID FIBER BASED "SHIELDS"**
    - **PBO FIBER BASED "SHIELDS"**
- **TRADITIONAL WOVEN FABRIC MATERIALS**
  - ***SPECTRA*® FIBER BASED WOVEN FABRICS**
  - **ARAMID FIBER BASED WOVEN FABRICS**
  - **PBO FIBER BASED WOVEN FABRICS**

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UNIDIRECTIONAL X-PLY MATERIALS

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- CONTINUOUS, UNIFORM FIBER WEB
- (0,90) FIBER ORIENTATION
- NO TWIST IN FIBERS
- NO AIR ENTANGLEMENT IN FIBERS
- THERMOPLASTIC RESIN
- ENGINEERED BONDING BETWEEN FIBERS AND RESIN
- THINNER LAYERS
- HIGHER PERFORMANCE AGAINST BULLETS
- GOOD PERFORMANCE AGAINST FRAGMENTS

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WOVEN FABRICS

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- TRADITIONAL TECHNOLOGY
- LOWER COST LOOMS
- LABOR INTENSIVE
- POSSIBILITY OF FIBER DAMAGE
- MECHANICAL LOCKING OF FIBERS
- FRICTIONAL LOCKING OF FIBERS
- EXPENSIVE FOR FINE DENIER FABRICS
- MAY REQUIRE QUILTING FOR LOW DEFORMATION

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WOVEN AND X-PLY MATERIALS

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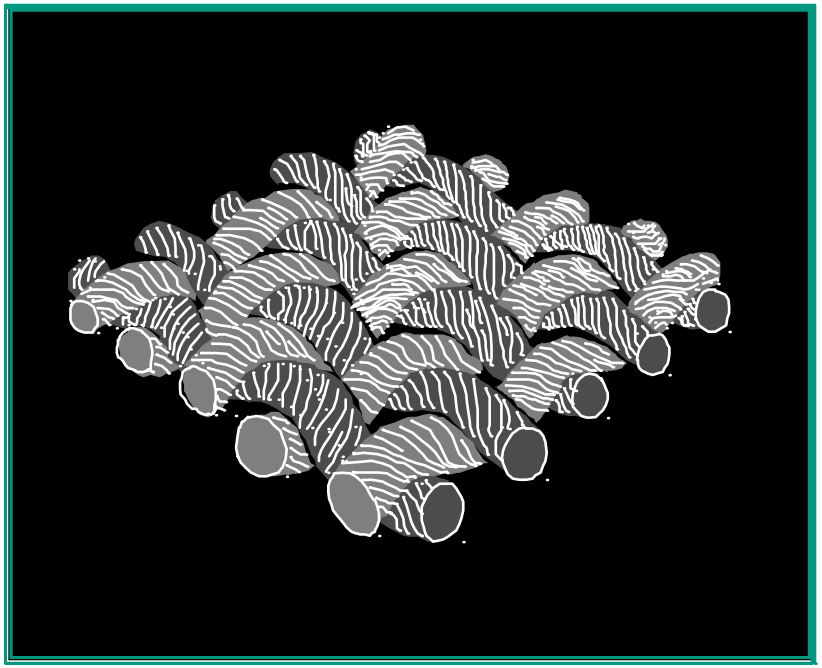
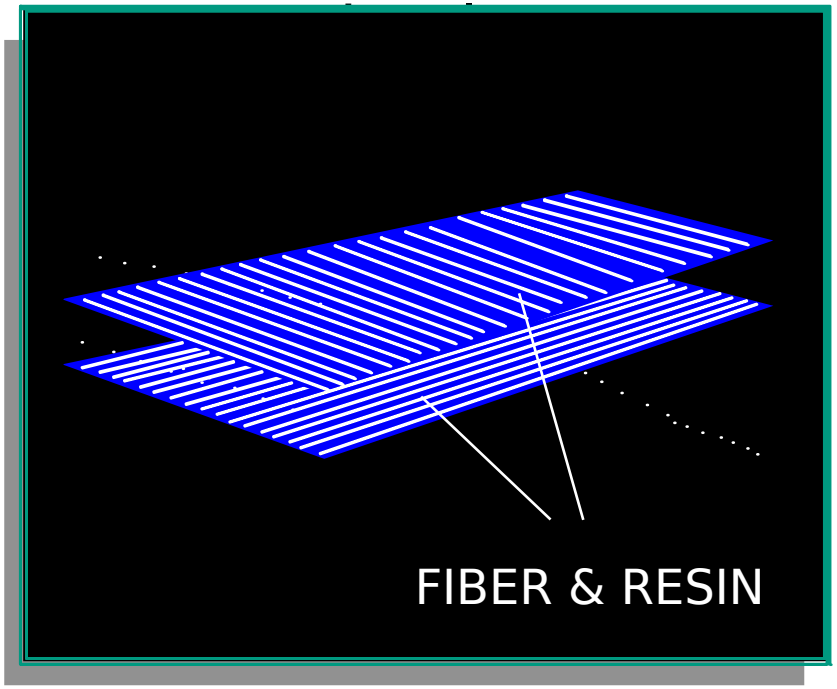
Woven Fabric



Non-woven
Crossplied



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ENERGY DISSIPATION

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TRADITIONAL WOVEN MATERIALS

UNIDIRECTIONAL CROSSPLIED MATERIALS

MILITARY SOFT ARMOR: SPECIFICATION

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- **US MILITARY SPECIFICATION**
  - **MINIMUM AREAL WEIGHT**
    - 1.00 ±0.05 PSF
  - **FRAGMENT RESISTANCE**
    - 2 , 4 , 16, 64 GRAIN RCC, V50 AT 0 DEGREE
    - 2 , 4 , 16, 64 GRAIN RCC, V50 AT 45 DEGREE
    - 9 MM FMJ BULLET PERFORMANCE

- **EUROPEAN & ASIAN MILITARY**
  - **MINIMUM AREAL WEIGHT**
  - **FRAGMENT RESISTANCE**
    - 17 GRAIN FSP

US MILITARY: CURRENT SOFT ARMOR

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- **MATERIAL: WOVEN ARAMID 400 & 600 DENIER FABRICS**
- **VEST CONSTRUCTION: WOVEN FABRIC LAYERS**
- **AREAL WEIGHT**
  - 1.05 PSF
- **PERFORMANCE**
  - 2 GRAIN RCC V50>2675 FPS
  - 4 GRAIN RCC V50>2363 FPS
  - 16 GRAIN RCC V50>2000 FPS
  - 64 GRAIN RCC V50> 1620 FPS
  - 9 MM FMJ @ 1500 FPS, DEFORMATION< 44 MM

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CROSSPLIED FRAGMENT MATERIALS

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- **SPECTRA SHIELD® LCR Material**
- **SPECTRA SHIELD® PLUS LCR Material**
- **GOLD FLEX ® Material**
- **HYBRIDS**
  - GOLD FLEX ® Material + SPECTRA SHIELD ® Material
  - GOLD FLEX ® Material+ SPECTRA SHIELD ® Material
  - SPECTRA SHIELD ® + SPECTRA® Woven Fabric Materials
  - Woven Aramid Fabric+ GOLD FLEX ® Material
  - Woven Aramid Fabric + SPECTRA SHIELD ® Material
  - Woven Aramid Fabric + SPECTRA SHIELD ® PLUS Material

BALLISTIC TESTING SET-UP

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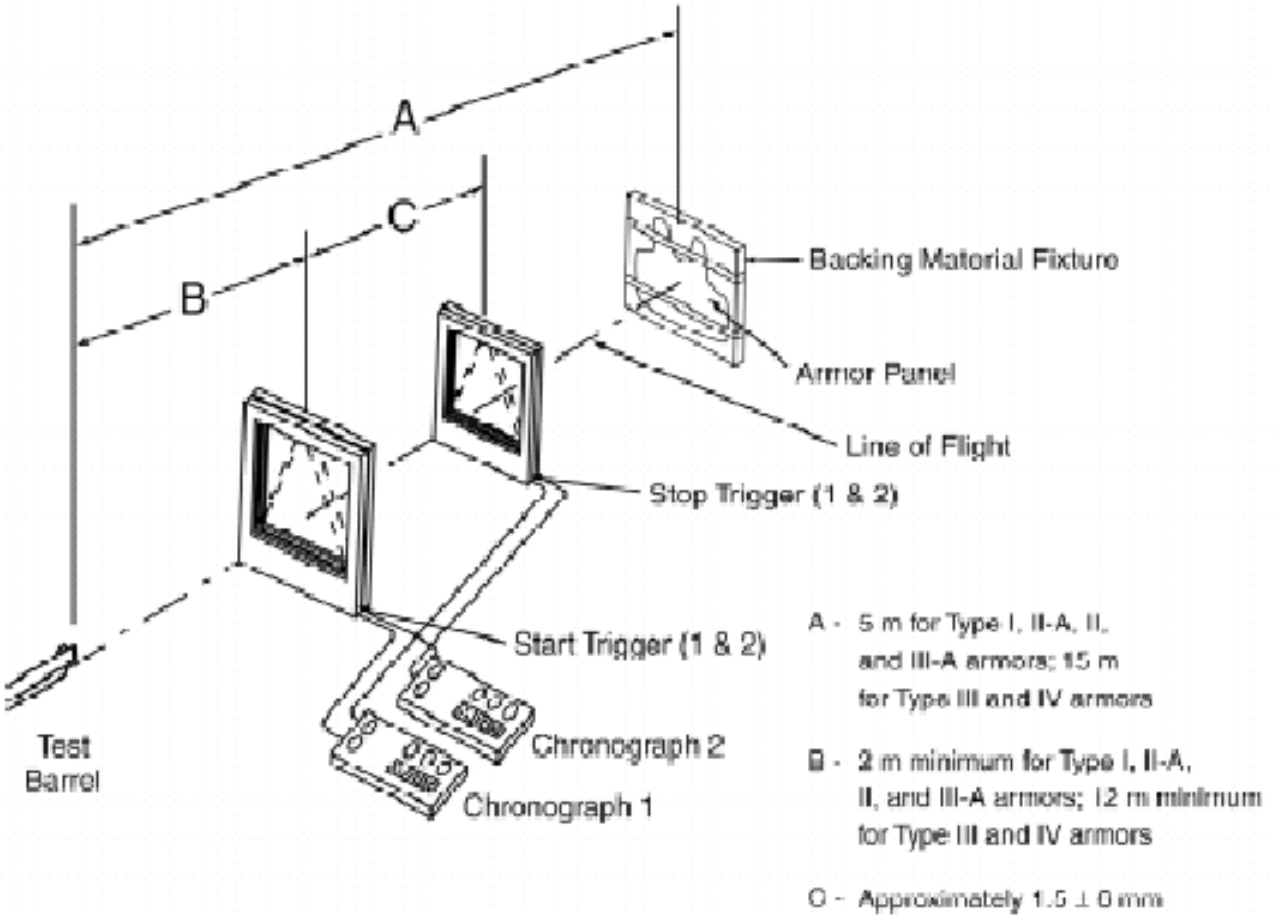
A
B
C
Backing Material Fixture
Armor Panel
Line of Flight
Stop Trigger (1 & 2)
Start Trigger (1 & 2)
Test
Barrel
Chronograph 2
Chronograph 1
A - 5 m for Type I, II-A, II, and III-A armors; 15 m for Type III and IV armors
B - 2 m minimum for Type I, II-A, II, and III-A armors; 12 m minimum for Type III and IV armors
C - Approximately 1.5 ± 0 mm

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BULLET & FRAG DEFORMATION

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FRAGMENT (RCC) PERFORMANCE OF VEST

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Materials	Arial Density (psf)	2 grRCC V50 (fps)	4grRCC V50 (fps)	16grRCC V50 (fps)	64grRCC V50 (fps)
Intercepter Vest Specification	1.05	2675	2360	2000	1620
SPECTRA Shield® LCR	1.00	2550	2210	1860	1550
SPECTRA Shield® PLUS LCR	0.97	2600	2310	1910	1615
Gold Flex	1.00	2605	2320	1990	1570
SPECTRA® Fabric 955	1.00	2650	2340	2000	1725
R & D Product A	0.97	2550	2315	2060	1428
R & D Product B	0.98			2050	1620
R & D Product C	1.02		2420	1990	1700

SUMMARY

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- **HIGHER FRAGMENT PERFORMANCE CAN BE ACHIEVED BY**
  - **NON-WOVEN SHIELD TECHNOLOGY BASED ON HMPE OR ARAMID FIBERS**
  - **MULTIPLE COMPONENT HYBRID FRAGMENT DESIGNS**

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